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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

AZ.2825

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/936674

INTERNATIONAL APPLICATION NO.

PCT/EP00/01984

INTERNATIONAL FILING DATE

08 March 2000

PRIORITY DATE CLAIMED

12 March 1999

TITLE OF INVENTION

APPARATUS FOR TREATING SUBSTRATES

APPLICANT(S) FOR DO/EO/US

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☒ has been previously submitted under 35 U.S.C. 154(d)(4).
- ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☐ Other items or information:

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Date of Deposit: 9/12/2001

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.


 Rosalie A. Centeno, Secretary

U.S. APPLICATION NO. (if known, see 37 CFR 1.2)

INTERNATIONAL APPLICATION NO.

ATTORNEY'S DOCKET NUMBER

AZ.2825

097/938674

PCT/EP00/01984

21. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):**

Neither international preliminary examination fee (37 CFR 1.482)
nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO
and International Search Report not prepared by the EPO or JPO. \$1000.00

International preliminary examination fee (37 CFR 1.482) not paid to
USPTO but International Search Report prepared by the EPO or JPO \$860.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO
but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO
but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO
and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =**CALCULATIONS PTO USE ONLY**

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Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30
months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	13 - 20 =		x \$18.00
Independent claims	1 - 3 =		x \$80.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$270.00
TOTAL OF ABOVE CALCULATIONS =			\$ 710.00
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+
SUBTOTAL =			\$ 710.00
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			\$
TOTAL NATIONAL FEE =			\$ 710.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +			\$
TOTAL FEES ENCLOSED =			\$ 710.00
			Amount to be refunded: \$
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SUBTOTAL =

\$ 710.00

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TOTAL NATIONAL FEE =

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TOTAL FEES ENCLOSED =

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Amount to be
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a. ☒ A check in the amount of \$ 710.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees.
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c. ☐ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. _____. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

ROBERT W. BECKER
11896 N. HIGHWAY 14 SUITE B
TIJERAS, NEW MEXICO 87059

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SIGNATURE

Robert W. Becker

NAME

26.255

REGISTRATION NUMBER

09/936674



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Evelyn L. Stump
Evelyn L. Stump, Secretary

In the Application of Wolfgang Kroeber

Ser. No.: 09/936,674

For: APPARATUS FOR TREATING SUBSTRATES

Filed on: September 12, 2001

Art Unit: Unknown

Examiner: Unknown

Assistant Commissioner for Patents

Washington, DC 20231

SUPPLEMENTAL AMENDMENT

Dear Sir or Madam:

This supplemental amendment is issued in order to correct and replace a paragraph on page 12 of the original specification.

IN THE SPECIFICATION:

Please replace the entire paragraph on page 12, beginning on line 5 and continuing through line 14, with the following:

On the outer side of the container wall 9 a contact element 37 in the form of a

contact spring is secured by means of a screw. The contact element 37 extends into the region of the undercut 35 of the seal 32 and is provided with a contact cusp or a rounded contact end 39. The rounded contact end 39 serves for the electrical contact of a rim region of a surface 40 of the wafer 31 that faces the process container 2. The electrically contacted rim region of the surface 40 of the wafer 31 is disposed radially beyond a contact region between the surface 40 and the seal 32, and is thus insulated relative to the interior of the process container 2.

REMARKS

In light of the foregoing amendment, Applicant respectfully submits that the present application now stands in condition for allowance. Action to this end is courteously solicited.

Respectfully submitted,



Robert W. Becker, Reg. No. 26,255
for applicant

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Tijeras, NM 87059

Telephone: (505) 286-3511
Facsimile: (505) 286-3524

Version with Markings to Show Changes Made

IN THE SPECIFICATION:

Please replace the entire paragraph on page 12, beginning on line 5 and continuing through line 14, with the following:

On the outer side of the container wall 9 a contact element 37 in the form of a contact spring is secured by means of a screw. The contact element 37 extends into the region of the undercut 35 of the seal 32 and is provided with [_____ cusp on??] a contact cusp or a rounded contact end 39. The rounded contact end 39 serves for the electrical contact of a rim region of a surface 40 of the wafer 31 that faces the process container 2. The electrically contacted rim region of the surface 40 of the wafer 31 is disposed radially beyond a contact region between the surface 40 and the seal 32, and is thus insulated relative to the interior of the process container 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.

Rosalie A. Centeno
Rosalie A. Centeno, Secretary

In the Application of Wolfgang Kroeber

Ser.No.: Not Yet Known (Based on PCT/EP00/01984 filed 08 March 2000 and
German priority documents 199 11 084.0 filed 12 March 1999)

For: APPARATUS FOR TREATING SUBSTRATES

Filed on: September 12, 2001

Assistant Commissioner for Patents

Washington, DC 20231

PRELIMINARY AMENDMENT ACCOMPANYING PCT NATIONAL STAGE APPLICATION

Sir:

Prior to examination, please amend the above-identified application as follows.

IN THE SPECIFICATION:

On page 1, immediately after the title, please insert the following heading:

--Background of the Invention--.

On page 3, at line 14, please insert the following heading:

--Summary of the Invention--.

On page 9, at line 9, please insert the following heading:

--Brief Description of the Drawing--;

On page 9, at line 20, please insert the following heading:

--Description of Preferred Embodiments--.

On page 11, at line 15, please delete "10" and replace with "2".

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On page 18, at line 22, please delete "10" and replace with "2".

On page 23, after line 22, please insert the following paragraphs:

--The specification incorporates by reference the disclosure of German priority document 199 11 084.0 of 12 March 1999 and International priority document PCT/EP00/01984 filed 08 March 2000.

The present invention is, of course, in no way restricted to the specific disclosure of the specification and drawings, but also encompasses any modifications within the scope of the appended claims.--

IN THE CLAIMS:

Please cancel claims 1 - 13, and replace them with the attached claims 14 - 33.

REMARKS

Claims 14 - 33 are pending in the application.

Appropriate headings have been added to the specification, and claims from the literal translation have been replaced by claims drafted in conformity with U.S. Patent practice.

The application in its amended state is believed to be in condition for allowance. However, should the Examiner have any comments or suggestions, or wish to discuss the merits of the application, the undersigned would very much welcome a telephone call in order to expedite placement of the application into condition for allowance.

Respectfully submitted,



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for Applicant(s)

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WHAT I CLAIM IS:

14. An apparatus for treating substrates, comprising:

5 a first process container which is provided with at least one opening in a wall of said first process container, wherein said at least one opening is closeable from outside of said first process container via a substrate; and

10 a second process container that is disposed adjacent to said first process container such that one wall of said second process container is at least partly said wall of said first process container in which said at least one opening is provided, whereby said at least said one opening is also closeable from the direction of said first process container.

15 15. An apparatus according to claim 14, wherein said at least one opening is formed in an essentially vertical wall of said first process container.

16. An apparatus according claim 14, wherein a sealing element is provided that forms a periphery of said at least one opening.

20 17. An apparatus according to claim 16, wherein said sealing element is provided with an undercut and a sealing lip, which are formed by milling out a sealing material that forms said sealing element.

18. An apparatus according to claim 16, wherein a contact element is provided to provide electrical contact with a surface of said

substrate that faces said first process container.

19. An apparatus according to claim 18, wherein said contact element extends into a region of an undercut of said sealing element.

20. An apparatus according to claim 14, wherein an electrode is disposed across from said at least one opening.

21. An apparatus according to claim 20, wherein said electrode is an electrode plate, especially an anode, and is provided with openings for allowing at least one fluid to pass through.

22. An apparatus according to claim 20, wherein said electrode is moveable toward and away from said at least one opening, and wherein said at least one opening is closeable by said electrode from the direction of said first process container.

23. An apparatus according to claim 22, wherein at least one sealing element is provided on at least one of said electrode and a container wall that surrounds said at least one opening.

24. An apparatus according to claim 23, wherein said at least one sealing element radially surrounds said electrode and projects axially beyond a surface that faces said at least one opening.

25. An apparatus according to claim 14, wherein at least one treatment fluid that is introducible into said first processing container is at least one of a metal-containing electrolyte and an etching medium.

26. An apparatus according to claim 14, wherein said second process container forms at least one of a rinsing chamber, a drying

chamber, and a surface-conditioning chamber.

27. An apparatus according to claim 14, wherein a substrate holder is provided that includes a main body and at least one vacuum finger that is moveable relative to said main body.

5 28. An apparatus according to claim 27, wherein said at least one vacuum finger is disposed centrally in a surface of said main body that faces said substrate, and is recessible in said main body of said substrate holder.

10 29. An apparatus according to claim 27, wherein a pressure sensor is disposed in a vacuum line that communicates with said at least one vacuum finger.

15 30. An apparatus according to claim 27, wherein a plurality of fixed vacuum openings are provided in a surface of said main body of said substrate holder that faces said substrate, and wherein said vacuum openings radially surround said at least one vacuum finger.

31. An apparatus according to claim 30, wherein said vacuum openings are supplyable with vacuum separately from said at least one vacuum finger.

20 32. An apparatus according to claim 30, wherein at least one sealing element is provided on said substrate holder and radially surrounds said vacuum openings.

33. An apparatus according to claim 32, wherein said sealing element is elastic and is disposed across from a further sealing

element, especially a sealing lip, that is provided at a periphery of said
at least one opening.

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Apparatus for Treating Substrates

5 The present invention relates to an apparatus for treating substrates, especially semiconductor wafers, and includes a process container having at least one opening, whereby the opening can be closed from the outside by the substrate.

10 An apparatus for treating substrates is known, for example, from Applicant's not prepublished DE 198 59 470. This apparatus has an upwardly open process tank through which a metal-containing electrolyte flows from the bottom toward the top. Along its path toward the top, the electrolyte flows through an anode that is embodied as an extended grating. A semiconductor wafer, which is to be plated with the metal found in the electrolyte, is held by a substrate holder over an upper edge of the process container in such a way that a flow gap is formed therebetween. The electrolyte that flows through the process tank is caused to overflow between the upper edge of the process container and the substrate, and is brought into contact with the wafer. By applying a voltage between the anode and the wafer, which is electrically contacted, the metal that is contained in the electrolyte is caused to deposit upon the wafer.

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With this apparatus, due to the aforementioned flow against the substrate, there results in the outer edge regions of the wafer, especially in the region of the gap between the wafer and the upper edge of the process container, higher flow speeds than in the central portion of the wafer. Due to these flow inhomogeneities, deposition inhomogeneities of the metal upon the wafer result. Gas bubbles that result during the deposition of the metal are generally carried along by the flow of the electrolyte, although they can collect in areas of relatively calm flow, where they adversely affect a further deposition of metal. Since the electrolyte flows through the anode that is disposed across from the wafer, the anode must have large flow openings, which adversely affect the production of a homogeneous electrical field between the anode and the wafer. For a further treatment of the wafer, such as a rinsing process, the substrate must be raised and possibly a rinsing-drying unit must be moved beneath the wafer, with such a unit being described in Applicant's not prepublished DE 198 59 469.

U.S.-A-5,437,777 discloses an apparatus for the treatment of substrates of the aforementioned type, according to which an opening of a process container is closed from the outside by a substrate that is to be treated. The opening is disposed in a vertical wall of the process container in order to achieve during a metal plating process a uniform

flow of a treatment fluid against the substrate. After a plating process, the substrate must be transferred in a complicated procedure in order to be treated, for example to be rinsed, in a further process container. During the transfer there results the danger of damage to the substrate due to the required handling steps. There furthermore exists the danger during the transfer that the treatment fluid dries on during the required transfer time and thereby damages the substrate.

It is therefore an object of the present invention to provide an apparatus of the aforementioned general type that enables a simple, homogeneous treatment of a substrate surface that is to be treated, and reduces the danger of damage to the substrate between successive treatment steps.

This object is inventively realized in that for the apparatus described initially a second process container is provided adjacent to the first process container, wherein a wall of the second process container is at least partially that container wall of the first process container that contains the opening. By providing the second process container, which shares with the first process container the wall that contains the opening, the substrate is disposed in the second process container during the treatment in the first process container, and after the

treatment in the first process container can be treated in the second container without any further transfer. The time periods between successive treatment steps can be considerably reduced, thereby considerably reducing the danger of having the treatment fluid dry on.

5 If the substrate does not close off the opening in the process containers, this opening is closed off from the side of the first process container in order to provide a separation of the two process containers. The provision of two separate process chambers furthermore reduces the carrying off of medium or the mixing of different media. By closing the opening of the first process container from the outside via the substrate, there is ensured in a straightforward manner that only that surface of the substrate that faces the process container will come into contact with a treatment fluid located in the process container, whereas the remaining portions of the substrate are 10 insulated therefrom. Furthermore, a lateral flow against the substrate is possible, with such flow extending essentially parallel to the substrate surface. As a result, a uniform flow against the substrate surface, and hence a uniform treatment, are achieved.

20 Pursuant to one particularly preferred specific embodiment of the present invention, the opening is formed in an essentially vertical wall of the process container, as a result of which, during filling of the

invention, the apparatus is provided with an electrode disposed across from the opening in order to generate an electrical field between the electrode and the substrate. In this connection, the electrode is preferably an electrode plate that makes it possible to apply a homogeneous electrical field. Pursuant to one preferred specific embodiment, the electrode plate has openings to allow at least one fluid, especially a drying fluid, to pass through in order to enable a directed, perpendicular fluid flow against the substrate that is disposed across from the electrode. The electrode is preferably an anode.

Pursuant to a further preferred specific embodiment of the invention, the electrode can be moved toward and away from the opening in order to adjust, if desired, the spacing between the electrode and the substrate. The opening of the process container can preferably be closed from the inside by the electrode in order to close off the process container from the atmosphere when it is not closed off by the substrate.

To ensure a sealed closing off of the opening by the electrode, at least one sealing element is provided on the electrode and/or on a container wall that surrounds the opening. In order to prevent impairment of the electrical field generated by the electrode, as well as on the substrate

side to prevent negative impacts from a fluid flow, the sealing element preferably radially surrounds the electrode and projects axially beyond a surface of the electrode that faces the opening.

5 Pursuant to one special specific embodiment of the apparatus, which serves for the metal plating of the substrate, at least one treatment fluid that can be introduced into the process container is a metal-containing electrolyte and/or an etching medium.

10 The second process container preferably forms a rinsing and/or drying chamber and/or a surface-conditioning chamber.

15 Pursuant to one preferred specific embodiment of the invention, the substrate is held by a substrate holder having at least one vacuum finger that is moveable relative to a main body of the substrate holder. By providing a vacuum finger that is moveable relative to the main body of the substrate holder, the substrate can be loaded and removed at a distance from the main body of the substrate holder, so that a substrate handling mechanism can be moved between the substrate and the main body of the substrate holder. For a reliable and uniform holding, the vacuum finger is preferably centrally arranged in a surface of the main body that faces the substrate. To bring the main body of

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the substrate holder into contact with the substrate, the vacuum finger is preferably recessible in the main body.

Pursuant to one preferred specific embodiment of the invention, a pressure sensor is provided in a vacuum line that is connected with the vacuum finger in order to let a wafer handling mechanism, which brings the substrate to the substrate holder, know when the substrate is reliably held on the vacuum finger.

In addition to the vacuum finger, the substrate holder preferably has a plurality of fixed vacuum openings in that surface of the main body that faces the substrate in order to fixedly hold the substrate on the substrate holder over larger areas. In this connection, the vacuum openings preferably radially surround the vacuum finger. The vacuum openings can advantageously be supplied with vacuum separately from the vacuum finger.

Pursuant to one preferred specific embodiment of the invention, at least one sealing element that radially surrounds the vacuum openings is provided on the substrate holder in order to ensure a good sealing of a vacuum region. The sealing element on the substrate holder is preferably elastic, and is disposed across from the sealing element on

the periphery of the opening, in particular the sealing lip, in order to provide the substrate in this region with a small movement clearance, thereby preventing the substrate from becoming damaged, in particular becoming crushed, between the sealing element at the periphery of the opening and the substrate holder. By providing the two sealing elements across from one another, the contact pressure is additionally transferred directly vertically by the substrate without transverse forces or tensions occurring in the substrate.

The present invention will be explained subsequently with the aid of preferred specific embodiments with reference to the figures. In the drawings:

Fig. 1 is a schematic illustration of one exemplary embodiment of the inventive embodiment;

Fig. 2 is an enlarged schematic illustration of the encircled portion of Fig. 1;

Fig. 3 is an alternative specific embodiment of the invention having two process containers.

Fig. 1 shows metal-plating apparatus 1 that includes a process container 2, an anode arrangement 3 that is moveably disposed within

the process container 2, and a substrate holder 4 that is disposed outside of said process container 2.

5 The process container 2 is formed by a bottom wall 6, a top wall 7, and appropriate side walls, of which a left side wall 8 and a right side wall 9 are shown. A process chamber 10 is formed between the walls of the process container 2. Provided in the bottom wall 6, next to the right side wall 9, is a combined inlet and outlet opening 11 that communicates with a conduit 12. By means of the conduit 12, i.e. the opening 11, a treatment fluid can be introduced into as well as discharged from the process container 2. Instead of a combined inlet and outlet connection, it would, of course, also be possible to provide two separate openings having corresponding conduits.

15 Provided in the top wall 7 is an opening 14 that communicates with an overflow conduit 15. The treatment fluid that is introduced from below flows out of the process container 2 via the opening 14 and the overflow conduit 15.

20 Provided in the left side wall 8 is a central opening 17 in which is disposed a displacement rod 19 of the anode arrangement 3. The displacement rod 19 of the anode arrangement 3 extends through the

central opening 17 and is connected on that end thereof that is disposed outside of the process container 2 with a non-illustrated linear movement unit. The end of the displacement rod 19 that is disposed within the process container 2 is connected to an anode plate 20 that extends parallel to the side wall 8 and essentially perpendicular to the displacement rod 19. The anode plate 20 is a closed plate having a planar surface 21 that faces the right side wall 9. Provided between the left side wall 8 and the rear side of the anode plate 20 is a seal member in the form of an O-ring 23 that is secured either to the side wall 8 or to the rear side of the anode plate 20. The anode plate 20 is radially surrounded by an O-ring 25 that projects beyond the surface 21 of the anode plate 20 in a direction toward the right side wall 9. The reference 26 indicates a sealing bellows that on its left side is connected to the displacement rod 19 and on its right side is connected to the first wall 8 of the container 10.

The right side wall 9 has a central opening 29, the dimensions of which are less than the dimensions of a substrate that is to be treated, such as a semiconductor wafer 31. The periphery of the opening 29 is formed by a seal 32, which can be best seen in the detailed view of Fig. 2. The seal 32 is fused or welded to an inner periphery of the right side wall 9, and is provided with a curved surface 33 that is directed

toward the opening 29. Formed in that side of the seal 32 that is opposite the surface 33 is an undercut 35 that is formed, for example, by milling out the material that forms the seal 32.

5 On the outer side of the container wall 9 a contact element 37 in the form of a contact spring is secured by means of a screw. The contact element 37 extends into the region of the undercut 35 of the seal 32 and is provided with _____ cusp on?? a rounded contact end 39. The rounded contact end 39 serves for the electrical contact of a rim region of a surface 40 of the wafer 31 that faces the process container 2. The electrically contacted rim region of the surface 40 of the wafer 31 is disposed radially beyond a contact region between the surface 40 and the seal 32, and is thus insulated relative to the interior of the process container 2.

15 The wafer 31 is carried by the substrate holder 4 and is moveable therewith toward the process container into a position in which the wafer 31 closes off the opening 29 in the side wall 9, and is moveable away from the process container 2 into a position in which the wafer 31 does not close off the opening 29.

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The substrate holder 4 is provided with a main body 42 and a

displacement rod 43 that is secured thereto. The displacement rod 43 can also be monolithically formed with the main body 42. Disposed in the main body 42 is a centrally arranged vacuum finger 44 that communicates with a vacuum line 45. Disposed in the vacuum line 45 is a non-illustrated pressure sensor that determines whether a sufficient vacuum for holding the wafer is maintained between the vacuum finger 44 and the wafer 41.

The vacuum finger 44 is laterally moveable out of and retractable into the main body 42, so that it is completely recessed in the main body 42. Furthermore provided in the main body 42 are a plurality of openings 47 that radially surround the vacuum finger 44 and communicate with a vacuum line 48 and that can further be supplied with a negative pressure or vacuum in order to pull the wafer 31 securely against the main body 42 of the substrate holder 4. The vacuum lines 45 and 48 can be separately supplied with a vacuum, although they could also be connected to a common source of vacuum.

As can be seen in Fig. 2, a groove 50, which accommodates an O-ring 51, is provided in the rim region of a surface of the main body 42 that faces the wafer 31. The O-ring 51 radially surrounds the vacuum openings 47 and thus provides a good radial seal of a vacuum area

formed between the wafer 31 and the main body 42 of the substrate holder 4. The O-ring 51 is disposed against the side wall 9 of the process container 2 in the region of the seal 32.

5 The treatment of the wafer 31 in the apparatus of Fig. 1 will be described subsequently.

10 The substrate holder 4 is first retracted and spaced from the process container 2. The vacuum finger 44 is moved out of the main body 42 of the substrate holder 4 and receives a wafer 31 that is brought into the region of the substrate holder 4 by a non-illustrated handling mechanism. The extended vacuum finger 44 makes it possible to move the handling mechanism into a space formed between the main body 42 and the substrate 31 and to transfer the substrate to the vacuum finger 44.

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20 After receipt of the substrate by the vacuum finger 44, the handling mechanism is released and moved out of the region between the wafer 31 and the main body 42 of the substrate holder 4. The vacuum finger 44 is then retracted into the main body 42 of the substrate holder 4. In so doing, one side of the wafer 31 comes into contact with the main body 42, and a vacuum is applied via the vacuum line 48 to the

vacuum openings 47 to ensure a reliable holding of the wafer 31 on the main body 42.

The substrate holder 4 is subsequently moved toward the process container 2 until the surface 40 of the wafer 31 comes into contact with the seal 32 on the side wall 9, thereby closing off and sealing the opening 29 in the side wall 9. At the same time, the rim region of the surface 40 of the wafer 31 comes into contact with the rounded contact end 39 of the contact element 37.

The process container 2 is subsequently filled with a metal-containing electrolyte, whereby the surface 40 of the wafer 31 is uniformly wetted with the electrolyte. A voltage is subsequently applied between the anode plate 20 and the electrically contacted wafer 31 in order to effect a deposition of the metal contained in the electrolyte upon the surface 40 of the wafer 31. In this connection, electrolyte is continuously introduced into the process container 2 via the opening 11 and flows out of the process container 2 via the opening 14. After an adequate deposition of the metal, the electrolyte is discharged from the process container 2 via the opening 11. During retraction of the substrate holder 4 from the process container 2, the anode plate 20 is moved through the process container 2 toward the side wall 9 until the seal 25

comes into contact with an inner surface of the side wall 9. In this way, the opening 29 of the process container 2 is sealed off from the inside and prevents contamination from entering the process container 2.

5 Alternatively, prior to moving the substrate holder 4 away, a rinsing and/or drying of the wafer 31 can be effected within the process container 2. To rinse the wafer 31, rinsing fluid is introduced into the process container 2 via the opening 11 or a separate opening, and the surface 40 of the wafer 31 is rinsed. To dry the wafer 31, the rinsing
10 fluid is slowly discharged, whereby first a solvent, such as an IPA layer, is applied to the surface of the rinsing fluid so that a drying is effected pursuant to the Marangoni principle.

15 Alternatively, openings can be provided in the anode plate 20 for allowing a drying fluid to pass through (as will be described subsequently in conjunction with Fig. 3.) Then, after discharge of the rinsing fluid, the anode plate 20 is moved into a position adjacent to the substrate 31 and drying fluid, such as N₂, is introduced via the openings onto the surface 40 of the substrate 31 in order to dry the
20 same.

The substrate holder 4 is subsequently moved away from the side wall

9 so that the wafer 31 can be removed from the substrate holder 4.

Fig. 3 shows an alternative embodiment of the present invention, according to which the metal-plating apparatus 1 is embodied in the form of a vertical dual process chamber. To the extent that this is expedient, in Fig. 3 the same reference numerals are used as with the embodiment of Fig. 1 in order to designate the same or similar elements.

The apparatus 1 has a first process container 2 that is essentially the same as the process container 2 of Fig. 1, as well as a second process container 60.

The process container 2 has a bottom wall 6, a top wall 7, as well as left and right side walls 8 and 9. Provided in the bottom wall 6 is a discharge opening 62 that communicates with a conduit 63.

Provided in the side wall 8, in the region of the bottom wall 6, is an inlet opening 64 that communicates with an inlet conduit 65.

Furthermore provided in the side wall 8, in the region of the top wall 7, is an overflow opening 66 that communicates with a conduit 67.

A displacement rod 19 of an anode arrangement 3 extends through a central opening 17 in the side wall 8 and is longitudinally displaceable within the process container 2.

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Provided in the displacement rod 19 is a longitudinally extending passage 70 that communicates with a non-illustrated source of fluid.

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An anode plate 20 of the anode arrangement 3 is provided with radially outwardly extending passages 72 that communicate with the passage 70 in the displacement rod 19. The passages 72 communicate with openings 74 in a surface 75 of the anode plate 20 that faces the side wall 9. By means of the passage 70, the passages 72 as well as the openings 74, a fluid, such as N_2 , can be conveyed through the anode arrangement 3. The surface formed by the opening is very small in comparison to the overall surface area of the surface 75 of the anode plate 20, so that the anode plate 20 can be seen as an essentially closed plate. As with the first exemplary embodiment, the anode plate 20 is radially surrounded by an O-ring 25. Again, a sealing bellows 26 is provided that on one side is connected to the displacement rod 19 and on the other side is connected with the first wall 8 of the container 10.

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The side wall 9 is again provided with an opening 29, the periphery of which is determined by a seal 32. The opening 29 can again be closed off from the outside by a wafer 31 and from the inside by the anode plate 20.

Provided adjacent to the first process container 2 is a process container 60, the left side wall of which is formed by the right side wall 9 of the first process container 2, which right side wall contains the opening 29. The second process container 60 is provided with a bottom wall 76, a top wall 77, the left side wall 9 as well as a right side wall 78. Provided in the bottom wall 76 is a combined inlet and outlet opening 81 that communicates with a conduit 82. Instead of a combined inlet and outlet opening, it is of course also possible to provide two separate openings.

Provided in the top wall 77 is an opening 84 that communicates with a conduit 85.

Provided in the right side wall 78 of the process container 60 is a central opening 87 through which extends a displacement rod 43 of the substrate holder 4. The reference 91 shows a sealing bellows that at

one end is connected with the displacement rod 43 of the substrate holder 4 and at its other end is connected with the right side wall 78 of the process container 60.

5 Disposed on or in the left side wall 9 of the second process container 60 is a nozzle 90 that faces the second process container 60 and via which a treatment fluid, such as a rinsing fluid, in particular deionized water, is introduced into the second process container 60. Instead of a single nozzle, a plurality of nozzles could also be provided.

10 The construction of the substrate holder 4 corresponds essentially to the construction of the substrate holder 4 of Fig. 1, whereby merely the form of the vacuum finger 44 as well as the form of the vacuum openings 47 differs from that shown in Fig. 1.

15 The operating sequence of the vertical dual process chamber is as follows:

20 The wafer 31 is vertically introduced into the second process container 60 via a non-illustrated, lateral opening thereof and by means of a wafer handling mechanism, and the wafer is accommodated on the substrate holder 4 in the manner described above. The substrate

holder 4 is subsequently moved in a direction toward the wall 9 until the wafer surface 40 comes into contact with the seal 32 on the opening 29, and the process containers 2 and 60 are sealed relative to one another. At the same time, the surface 40 of the wafer is electrically contacted in the manner described above directly behind the seal 32.

After the process chambers have been sealed, a metal-containing electrolyte is introduced into the process container 2 via the opening 64 until it overflows the opening 66. A voltage is thereafter applied between the wafer 31 and the anode plate 20, resulting in a deposition of metal upon the surface 40 of the wafer 31. After conclusion of the deposition process, the electrolyte is discharged from the process container via the opening 62.

The substrate holder 4, with the wafer 31 held thereon, is subsequently moved away from the common wall 9 of the process chambers 2 and 60. At the same time, the anode arrangement 3 is moved in a direction toward the wall 9 until the O-ring 25 comes into contact with the common wall 9 and the two process containers 2 and 60 are sealed relative to one another by the anode arrangement 3.

Rinsing fluid, for example deionized water, is now introduced via the

nozzle 90 and/or the opening 81 into the second process container 60 and the wafer is rinsed. After an adequate rinsing, the deionized water is discharged. To dry the wafer, a drying fluid, such as N₂, is then introduced into the process container 60 via the opening in the anode, and is blown against the wafer. For the drying process, the spacing between the anode plate and the wafer 31 can be reduced by moving the substrate holder 4 toward the wall 9.

As an alternative drying variation, the Marangoni principle can also be utilized. For this purpose, prior to the discharge of the deionized water, a solvent, such as IPA, is introduced into the process container 60 from above via the opening 84. The deionized water is subsequently discharged, and the wafer 31 is dried pursuant to the Marangoni principle.

The thus treated and dried substrate is subsequently removed from the non-illustrated lateral opening of the container 60.

The present invention has been described with the aid of preferred specific embodiments of the invention, without, however, being limited to the specific embodiments. For example, it is not necessary for the opening 29, which can be closed off by the wafer 31, to be formed in a

vertical side wall. The opening 29, could, for example, also be formed in a bottom wall of a treatment device, whereby the respective treatment fluid inlets and outlets must be appropriately adapted. The movement of the substrate holder and the anode arrangement could be controlled in such a way that at every point in time the anode plate and/or the wafer seals the opening 29. Furthermore, the anode arrangement can be embodied as a combined rinsing and drying unit by means of which the rinsing and drying fluid is introduced onto the wafer that is disposed across the anode plate 20. In this connection, the anode plate could, for example, have a construction that includes a centered rinsing fluid nozzle and drying fluid nozzles that extend tangentially thereto. The construction of such a combined rinsing and drying unit is described, for example, in Applicant's not prepublished DE 198 59 466, which is incorporated herein by reference to avoid unnecessary repetition. The bottom walls, the upper walls, as well as the non-illustrated side walls of the process containers can be monolithically formed. Furthermore, the bottom walls can be funnel shaped in order to achieve a better discharge of the respective treatment fluid. In particular, the respective chambers can also be used for different processes. For example, an etching medium can be introduced into the process chambers, and the second chamber can be embodied as a surface-conditioning chamber.

Patent Claims

1. Apparatus (1) for the treatment of substrates (31), especially semiconductor wafers, with a first process container (2) that has at least one opening (29), whereby the opening (29) can be closed by the substrate (31) from the outside, characterized by a second process container (60) that is provided adjacent to the process container (2), wherein one wall (9) of the second process container is at least partially that container wall (9) of the first process container (2) that contains the opening, whereby the opening (29) can be closed from the direction of the first process container.
2. Apparatus (1) according to claim 1, characterized in that the opening (29) is formed in an essentially vertical wall (9) of the process container (2).
3. Apparatus (1) according to one of the preceding claims, characterized by a sealing element (32) that forms the periphery of the opening (29), wherein the sealing element in particular has an undercut (35) in the sealing lip that is formed in particular by milling out a sealing material that forms the sealing element (32).
4. Apparatus (1) according to one of the preceding claims,

characterized by a contact element (37) for the electrical contacting of that surface (40) of the substrate (31) that faces the process container (2), wherein the contact element in particular extends into the region of the undercut (35) of the sealing element (32).

- 5 5. Apparatus (1) according to one of the preceding claims, characterized by an electrode (20) that is disposed across from the opening (29) and that in particular is an electrode plate (20) and has openings (74) allowing at least one fluid to pass through and that is in particular an anode.
- 10 6. Apparatus (1) according to claim 5, characterized in that the electrode (20) can be moved toward and away from the opening (29), and in particular the opening (29) can be closed off by the electrode (20) from the direction of the first process container.
- 15 7. Apparatus (1) according to claim 6, characterized by at least one sealing element (25) on the electrode (20) and/or on a container wall (9) that surrounds the opening (29), wherein the sealing element in particular radially surrounds the electrode and extends axially beyond a surface that faces the opening (29).
- 20 8. Apparatus (1) according to one of the preceding claims,

characterized in that at least one treatment fluid that can be introduced into the process container (2) is a metal-containing electrolyte and/or an etching medium.

9. Apparatus (1) according to one of the preceding claims, characterized in that the second process container (60) forms a rinsing and/or drying chamber and/or a surface-conditioning chamber.
10. Apparatus (1) according to one of the preceding claims, characterized by a substrate holder (4) having at least one vacuum finger (44) that is moveable relative to a main body (42) of the substrate holder (4) and that in particular is disposed centrally in a surface of the main body (42) that faces the substrate (31) and in particular is recessible in the main body (42) of the substrate holder (4).
11. Apparatus (1) according to claim 10, characterized by a pressure sensor in a vacuum line (45) that is connected with the vacuum finger (44).
12. Apparatus (1) according to one of the claims 10 or 11, characterized by a plurality of fixed vacuum openings (47) in that surface of the main body (42) of the substrate holder (4) that faces the substrate (31), wherein the vacuum openings in particular radially surround the vacuum finger (44) and in

particular can be supplied with vacuum separately from the vacuum finger (44).

13. Apparatus (1) according to one of the claims 10 to 12, characterized by at least one sealing element (51) on the substrate holder (4) that radially surrounds the vacuum openings (47), that is in particular elastic, and that is disposed across from the sealing element (32) on the periphery of the opening (29), in particular the sealing lip.

Wolfgang Kroeber

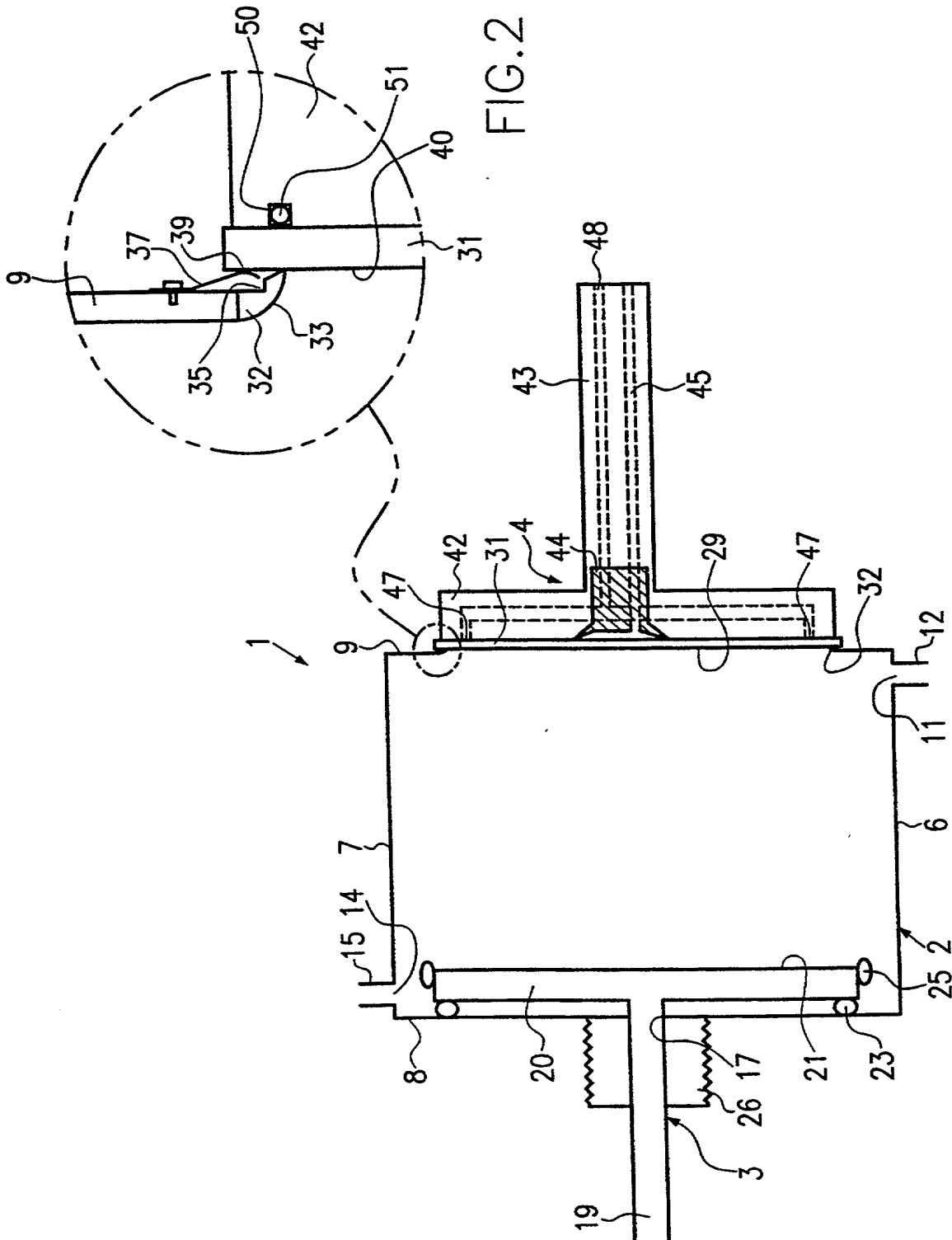


FIG. 1

FIG. 2





COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, we hereby declare that:

Our residences, post office addresses and citizenships are as stated below next to our names; we believe are the original, first and joint inventors of the subject matter which is claimed and for which a patent is sought of the invention entitled:

APPARATUS FOR TREATING SUBSTRATES
the specification of which

_____ is attached hereto;

xx was filed on 08 March 2000 as International Application Ser. No. PCT/EP00/01984 and is amended herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known by me to be material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Applications:

Priority
Claimed:

(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
199 11 084.0	Germany	12 March 1999	X	

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

(Application Number) (Filing Date)

I hereby appoint attorney Robert W. Becker, Reg. No. 26,255, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith. Address all telephone calls to (505) 286-3511. Address all correspondence to ROBERT W. BECKER & ASSOCIATES, 11896 N. Highway 14, Suite B, Tijeras, New Mexico 87059.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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